Final Outbrief of the Representation of C2 Decision Making in Combat Simulations Workshop

Conducted February 27-28, 1996

Topics of Discussion

- **Background/Objectives**
- **Setting the Simulation Context**
- **Bottom Line**
- **Key Components in Simulating Command Decision Process**
- **Notional Decomposition of the Command Decision Process**
- **Command Decision Process Used for Higher Echelon Simulations**
- **Higher Echelon Simulation Technology Implications**

Topics of Discussion

(cont'd)

- **Command Decision Process Used for Low Echelon Simulations**
- **Low Echelon Simulations Technology Implications**
- **Technology Issues**
- **Research Issues / A Focus for Further Work**

Background and Objectives

- **Background**
  - **DMSO sponsored 2 day workshop on “Representation of Command and Control Decision Making in Combat Simulations”**
  - **~65 participants from throughout DoD, industry and academia**
  - **presentations by current “practitioners”**
  - **outbrief and copy of individual briefs to be put on web page**
- **Objective**
  - **Provide technical overview of current state of practice in simulating command decision making to support DoD simulation initiatives (i.e., JWARS, JSIMS, etc..)**

Setting the Simulation Context

- **Command Decision Making is part Science and part Art**
- **Elements of Command Decision Making include:**

Science	Art
Computing Requirements	**Leadership**
Monitoring Status	**Intelligence Analysis**
Correcting Deviations	**Visualizing a Future State**
Monitoring Status	***Anticipating / Projecting Change**
Reallocating Assets	***Concept Formulation**
	***Prioritizing**

- **We are simulating the science and trying to emulate the *art**

Bottom Line

- **There is an emerging paradigm for simulating decision making**
- **Representation of the command decision process is only partly achievable today**
- **Progress has been made in simulating general techniques for command decision modeling and simulating command decisions**
- **Although they're becoming more flexible in responding to change, simulated commanders lack innovation / anticipation / leadership in shaping the battle. Decisions are made in a nuance-free environment**
- **Human-in-the-loop needed to supplement simulated higher commanders. Current simulations must be "monitored" to assure decisions are consistent with battle situation**

Key Components in Simulating Command Decision Process *

- **Simulated Battle Context of Command Decision Making**
  - **level of decision process (platform unit -- high echelon)**
  - **representation of current battle state (ground truth -- fused intelligence)**
  - **representation of commanders battle plan**
  - **representation of enemy objective**
- **Simulating the Commander's Decision Process**
  - **assessing current state of battle (ground truth vs objective related)**
  - **developing a course of action (reactive vs dynamic)**
  - **maintaining a doctrinal context**

* From TOR

Key Components in Simulating Command Decision Process * (cont'd)

- **Simulated Support to the Decision Process**
  - **fidelity / impact of sensor representation**
  - **context of information operations**
- **Architectural Aspects of Simulated Decision Makers**
  - **intermixing live staffs with simulated commanders**
  - **levels of simulation fidelity to track battle decision impacts**

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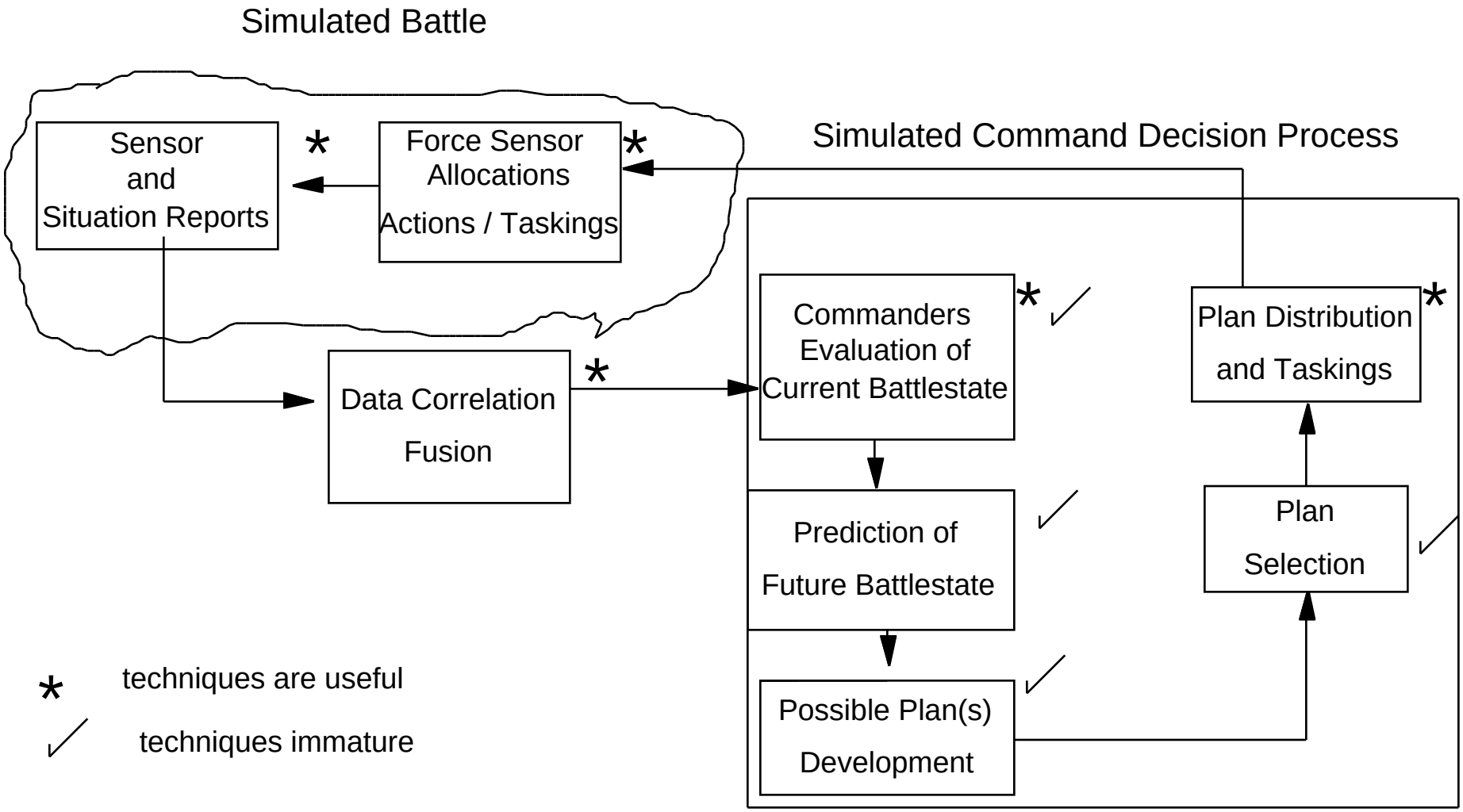
Notional Decomposition of the Command Decision Process



Command Decision Process Used for Higher Echelon Simulations

- **Higher echelon simulations (Theater / Force / Unit) are primarily closed-form analytic simulations (Navy NSS, Army - VIC)**
- **Command Nodes represented at most unit commander levels, rarely at the weapon system level (except NSS)**
- **Focus of command decisions are resource (sensor, support, unit reassignment) allocations**
- **Simulated Commander evaluates battle in context of predefined scenario objectives**
- **Battles are managed in “near-term allocation context”, not long-term strategic decisions**

Higher Echelon Simulation Technology Implications

- **Good News:**
  - **high value sensor resources / taskings / impact on delivery of information are represented (timing, geometry, performance envelopes)**
  - **command entities are represented at all echelons**
  - **primary “commanders evaluation” method is rule bases / decision tables**
  - **cause and effect relationships (sensor- communications - commander - shooter) are defined**
  - **some ability to represent situation report in actual tactical device formats**
  - **some flexibility in replanning (AP approach)**

Higher Echelon Simulation Technology Implications

- **Bad News:**
  - **simulated commander decisions rigidly adhere to scenario objectives. Pieces of "key" information implicitly defined by scenario**
  - **Rule base / decision table structures limit flexibility for plan innovation; coordination**
  - **Doctrinal implications at Joint levels unclear**

Command Decision Processes for Low Echelon Simulations

- **Virtual simulations (ModSAF, CFOR) focus at platform and first echelon (company, platoon) nodes. Also focus on mission analysis and course of action generation.**
- **Source of command decisions are tactical and near-term battle effectiveness of platforms (selection of movement routes, battle positions, target selections)**
- **Simulated commanders evaluate battle in terms of externally provided mission/objectives and localized threat**
- **Battle decisions are managed at platform to "nearest horizon"**

Low Echelon Simulations Technology Implications

- **Good News:**
  - **DARPA Command Forces Project making some inroads in developing simulated company commanders. First efforts are focused at automatically selecting proper movement / battle positions and reacting to localized threat**
  - **fundamental architecture (rule and task frame based) fairly robust in generation of flexible platform routes and platform coordination**
  - **orders and missions being distributed in common simulation language (CCSIL -- Command & Control Simulation Interface Language)**
  - **some flexibility due to rapid rate of replanning (partial plan - act - assess - plan extension)**

Low Echelon Simulations Technology Implications

- **Bad News:**
  - **DARPA work to date only addresses ground maneuver (no fire support, no localized sensor management, no CSS)**
  - **Architectures, especially those for C2 representations are valuable insofar as they enable the use of libraries. The lack of extensive libraries limits implementation of state of the art**
  - **No “learning” capabilities have been created and used in existing representations**

Technology Issues

- **The ability to simulate the command decision process has benefited from focused research and improved computational technologies**
  - **5 years ago the workshop would have had minimal attendance**
  - **research into artificial intelligence techniques has enabled simulation of planning / replanning, textual message communications and limited reaction to localized battle situation**
  - **evolving simulation system architectures and object schemas facilitates C2 representation considerably**
- **Robustness is an issue with most systems**
- **Simulations represent a traditional C2 process in a mid-intensity environment (not OOTW or other efforts enhanced by IO)**

Research Areas/ A Focus for Further Work

- **Continued attention to the implications schemas is a necessary investment in enabling powerful of simulation architectures and C2 object class , flexible, and credible Command Decision Processor representation**
- **Investments over past 5 years in the application of traditional artificial intelligence (AI) structures are yielding dividends. Continued application in area of planning, decision making (especially with uncertain information), natural language understanding (in the C2 context), and learning**
- **Current understanding of decision making grounded in traditional force structures. Must begin to consider role of C3I in information warfare (IW) context**